An Introduction To Planetary Atmospheres

Transfer of Polarized Light in Planetary AtmospheresAtmospheric Evolution on Inhabited and Lifeless WorldsAstronomyVision and Voyages for Planetary Science in the Decade 2013-2022Solar System AstrophysicsSolar Planetary SystemsLight Scattering in Planetary AtmospheresPrinciples of Planetary ClimatePhotochemistry of Planetary AtmospheresTheory of Planetary AtmospheresPlanetary Atmospheric ElectricityPlanetary SciencesAn Introduction to the Solar SystemAn Introduction to Atmospheric PhysicsPlanets and Their Atmospheres: Origin and EvolutionGeology and Habitability of Terrestrial PlanetsAlien SkiesNon-LTE Radiative Transfer in the AtmosphereTheory of Planetary AtmospheresPlanetary AtmospheresPlanetary AeronomySpectroscopy and Radiative Transfer of Planetary AtmospheresAstrobiologyPlanetary ClimatesPlanets: Ours and OthersOrigin and Evolution of Planetary and Satellite AtmospheresIntroduction to Circulating AtmospheresTheory of Planetary AtmospheresExoplanetary AtmospheresAn Introduction to Planetary AtmospheresGiant Planets of Our Solar SystemAstrophysics of Exoplanetary AtmospheresThe Atmosphere and Climate of MarsFundamental Planetary ScienceExoplanet AtmospheresAn Introduction to Atmospheric RadiationPlanets and Planetary SystemsIntroduction to Planetary ScienceTitanEarth as an Evolving Planetary System

Transfer of Polarized Light in Planetary Atmospheres

The book covers the field of solar system astrophysics beginning with basic tools of spherical astronomy and coordinate frames and celestial mechanics. It therefore presents equations and derivations starting from a level that permits one to see the underlying physical ideas. An up-to-date overview on all essential topics is presented, but is concise where possible. The text is based on extensive experience in the classroom and its contents have been field-tested by students for years. The material has been updated in the last few months to take advantage of the newer discoveries of the Mars Rover and the Saturn Cassini missions.

Atmospheric Evolution on Inhabited and Lifeless Worlds

An advanced undergraduate text on the large scale circulation of the atmosphere.

Astronomy

Over the past twenty years, astronomers have identified hundreds of extrasolar planets--planets orbiting stars other than the sun. Recent research in this burgeoning field has made it possible to observe and measure the atmospheres of these exoplanets. This is the first textbook to describe the basic physical

processes--including radiative transfer, molecular absorption, and chemical processes--common to all planetary atmospheres, as well as the transit, eclipse, and thermal phase variation observations that are unique to exoplanets. In each chapter, Sara Seager offers a conceptual introduction, examples that combine the relevant physics equations with real data, and exercises. Topics range from foundational knowledge, such as the origin of atmospheric composition and planetary spectra, to more advanced concepts, such as solutions to the radiative transfer equation, polarization, and molecular and condensate opacities. Since planets vary widely in their atmospheric properties, Seager emphasizes the major physical processes that govern all planetary atmospheres. Moving from first principles to cutting-edge research, Exoplanet Atmospheres is an ideal resource for students and researchers in astronomy and earth sciences, one that will help prepare them for the next generation of planetary science. The first textbook to describe exoplanet atmospheres Illustrates concepts using examples grounded in real data Provides a step-by-step guide to understanding the structure and emergent spectrum of a planetary atmosphere Includes exercises for students

Vision and Voyages for Planetary Science in the Decade 2013-2022

This work offers a broad coverage of atmospheric physics, including atmospheric thermodynamics, radiative transfer, atmospheric fluid dynamics and elementary atmospheric chemistry.

Solar System Astrophysics

Planetary atmospheres is a relatively new, interdisciplinary subject that incorporates various areas of the physical and chemical sciences, including geophysics, geophysical fluid dynamics, atmospheric science, astronomy, and astrophysics. Providing a much-needed resource for this cross-disciplinary field, An Introduction to Planetary Atmospheres presents current knowledge on atmospheres and the fundamental mechanisms operating on them. The author treats the topics in a comparative manner among the different solar system bodies—what is known as comparative planetology. Based on an established course, this comprehensive text covers a panorama of solar system bodies and their relevant general properties. It explores the origin and evolution of atmospheres, along with their chemical composition and thermal structure. It also describes cloud formation and properties, mechanisms in thin and upper atmospheres, and meteorology and dynamics. Each chapter focuses on these atmospheric topics in the way classically done for the Earth's atmosphere and summarizes the most important aspects in the field. The study of planetary atmospheres is fundamental to understanding the origin of the solar system, the formation mechanisms of planets and satellites, and the day-to-day behavior and evolution of Earth's atmosphere. With many interesting real-world examples, this book offers a unified vision of the chemical and physical processes occurring in planetary atmospheres. Ancillaries are available at www.ajax.ehu.es/planetary_atmospheres/

Solar Planetary Systems

Our subject is, of course, nothing more than applied physics and chemistry. But in addition to those basic sciences the student of planetary atmospheres needs an overview of atmospheric structure and physical processes as presently understood. This book is intended to help fill that need for both graduate students and research scientists. Although the approach is mainly theoretical, very little basic physics is developed here. Material that is standard fare in third- and fourth-year physics courses is simply absorbed where needed.

Light Scattering in Planetary Atmospheres

An essential introduction to the theory of exoplanetary atmospheres The study of exoplanetary atmospheres—that is, of planets orbiting stars beyond our solar system—may be our best hope for discovering life elsewhere in the universe. This dynamic, interdisciplinary field requires practitioners to apply knowledge from atmospheric and climate science, astronomy and astrophysics, chemistry, geology and geophysics, planetary science, and even biology. Exoplanetary Atmospheres provides an essential introduction to the theoretical foundations of this cutting-edge new science. Exoplanetary Atmospheres covers the physics of radiation, fluid dynamics, atmospheric chemistry, and atmospheric escape. It draws on simple analytical models to aid learning, and features a wealth of problem sets, some

of which are open-ended. This authoritative and accessible graduate textbook uses a coherent and self-consistent set of notation and definitions throughout, and also includes appendixes containing useful formulae in thermodynamics and vector calculus as well as selected Python scripts. Exoplanetary Atmospheres prepares PhD students for research careers in the field, and is ideal for self-study as well as for use in a course setting. The first graduate textbook on the theory of exoplanetary atmospheres Unifies knowledge from atmospheric and climate science, astronomy and astrophysics, chemistry, planetary science, and more Covers radiative transfer, fluid dynamics, atmospheric chemistry, and atmospheric escape Provides simple analytical models and a wealth of problem sets Includes appendixes on thermodynamics, vector calculus, tabulated Gibbs free energies, and Python scripts Solutions manual (available only to professors)

Principles of Planetary Climate

Astrobiology is a multidisciplinary pursuit that in various guises encompasses astronomy, chemistry, planetary and Earth sciences, and biology. It relies on mathematical, statistical, and computer modeling for theory, and space science, engineering, and computing to implement observational and experimental work. Consequently, when studying astrobiology, a broad scientific canvas is needed. For example, it is now clear that the Earth operates as a system; it is no longer appropriate to think in terms of geology, oceans, atmosphere, and life as being

separate. Reflecting this multiscience approach, Astrobiology: An Introduction: Covers topics such as stellar evolution, cosmic chemistry, planet formation, habitable zones, terrestrial biochemistry, and exoplanetary systems Discusses the origin, evolution, distribution, and future of life in the universe in an accessible manner, sparing calculus, curly arrow chemistry, and modeling details Contains problems and worked examples, and includes a solutions manual with qualifying course adoption Astrobiology: An Introduction provides a full introduction to astrobiology suitable for university students at all levels.

Photochemistry of Planetary Atmospheres

This book covers the basic physics of planetary atmospheres, providing an overview, followed by detailed discussion of key topics arranged by physical phenomenon. The emphasis is on acquiring and interpreting measurements, and the basic physics of instruments and models, with key definitions and historical notes given in the footnotes and glossary.

Theory of Planetary Atmospheres

Spectroscopy and radiative transfer are rapidly growing fields within atmospheric and planetary science with implications on various fields. Remote sensing and modeling atmospheric composition require detailed knowledge of how radiation and matter interact in planetary atmospheres. This book

provides this fundamental knowledge to a depth that will leave a student with the background to become capable of performing quantitative research on atmospheres. The book is intended for graduate students or for advanced undergraduates. It spans across principles through applications, with sufficient background for students without prior experience in either spectroscopy or radiative transfer. Courses based on this book are intended to be accompanied by the development of increasing sophisticated atmospheric and spectroscopic modeling capability (ideally, the student develops a computer model for simulation of atmospheric spectra from microwave through ultraviolet).

Planetary Atmospheric Electricity

A comprehensive and authoritative text on the formation and evolution of planetary atmospheres, for graduate-level students and researchers.

Planetary Sciences

Light Scattering in Planetary Atmospheres details the theory of radiative transfer for anisotropic scattering. The title emphasizes more on the theoretical aspects, and such focuses more on the fundamental concepts and basic principles rather than the practical application. The text first presents the basic equations, and then proceeds to tackling specific concepts in the subsequent chapters. Chapter 2 discusses the semi-infinite atmospheres, while Chapter 3 tackles atmospheres of finite optical

thickness. Next, the selection talks about atmospheres overlying a reflecting surface. The next two chapters in the title discuss the general theory. The seventh chapter details the linear integral equation, while the eighth chapter covers the approximate formulas. The text also deals with the determination of the physical characteristics of planetary atmospheres, along with the theory of radiative transfer in spherical atmospheres. The book will be of great use to scientists involved in the study of celestial bodies, such as astronomers and astrophysicists.

An Introduction to the Solar System

Astronomy is written in clear non-technical language, with the occasional touch of humor and a wide range of clarifying illustrations. It has many analogies drawn from everyday life to help non-science majors appreciate, on their own terms, what our modern exploration of the universe is revealing. The book can be used for either aone-semester or two-semester introductory course (bear in mind, you can customize your version and include only those chapters or sections you will be teaching.) It is made available free of charge in electronic form (and low cost in printed form) to students around the world. If you have ever thrown up your hands in despair over the spiraling cost of astronomy textbooks, you owe your students a good look at this one. Coverage and Scope Astronomy was written, updated, and reviewed by a broad range of astronomers and astronomy educators in a strong community effort. It is designed to meet

scope and sequence requirements of introductory astronomy courses nationwide. Chapter 1: Science and the Universe: A Brief Tour Chapter 2: Observing the Sky: The Birth of Astronomy Chapter 3: Orbits and Gravity Chapter 4: Earth, Moon, and Sky Chapter 5: Radiation and Spectra Chapter 6: Astronomical Instruments Chapter 7: Other Worlds: An Introduction to the Solar System Chapter 8: Earth as a Planet Chapter 9: Cratered Worlds Chapter 10: Earthlike Planets: Venus and Mars Chapter 11: The Giant Planets Chapter 12: Rings, Moons, and Pluto Chapter 13: Comets and Asteroids: Debris of the Solar System Chapter 14: Cosmic Samples and the Origin of the Solar System Chapter 15: The Sun: A Garden-Variety Star Chapter 16: The Sun: A Nuclear Powerhouse Chapter 17: Analyzing Starlight Chapter 18: The Stars: A Celestial Census Chapter 19: Celestial Distances Chapter 20: Between the Stars: Gas and Dust in Space Chapter 21: The Birth of Stars and the Discovery of Planets outside the Solar System Chapter 22: Stars from Adolescence to Old Age Chapter 23: The Death of Stars Chapter 24: Black Holes and Curved Spacetime Chapter 25: The Milky Way Galaxy Chapter 26: Galaxies Chapter 27: Active Galaxies, Quasars, and Supermassive Black Holes Chapter 28: The Evolution and Distribution of Galaxies Chapter 29: The Big Bang Chapter 30: Life in the Universe Appendix A: How to Study for Your Introductory Astronomy Course Appendix B: Astronomy Websites, Pictures, and Apps Appendix C: Scientific Notation Appendix D: Units Used in Science Appendix E: Some Useful Constants for Astronomy Appendix F: Physical and Orbital Data for the Planets Appendix G: Selected Moons of the Planets Appendix H: Upcoming Total

Eclipses Appendix I: The Nearest Stars, Brown Dwarfs, and White Dwarfs Appendix J: The Brightest Twenty Stars Appendix K: The Chemical Elements Appendix L: The Constellations Appendix M: Star Charts and Sky Event Resources

An Introduction to Atmospheric Physics

This book introduces the reader to all the basic physical building blocks of climate needed to understand the present and past climate of Earth, the climates of Solar System planets, and the climates of extrasolar planets. These building blocks include thermodynamics, infrared radiative transfer, scattering, surface heat transfer and various processes governing the evolution of atmospheric composition. Nearly four hundred problems are supplied to help consolidate the reader's understanding, and to lead the reader towards original research on planetary climate. This textbook is invaluable for advanced undergraduate or beginning graduate students in atmospheric science, Earth and planetary science, astrobiology, and physics. It also provides a superb reference text for researchers in these subjects, and is very suitable for academic researchers trained in physics or chemistry who wish to rapidly gain enough background to participate in the excitement of the new research opportunities opening in planetary climate.

Planets and Their Atmospheres: Origin and Evolution

A quantitative introduction to the Solar System and planetary systems science for advanced undergraduate students, this engaging textbook explains the wide variety of physical, chemical and geological processes that govern the motions and properties of planets. The authors provide an overview of our current knowledge and discuss some of the unanswered questions at the forefront of research in planetary science and astrobiology today. This updated edition contains the latest data, new references and planetary images and an extensively rewritten chapter on current research on exoplanets. The text concludes with an introduction to the fundamental properties of living organisms and the relationship that life has to its host planet. With more than 200 exercises to help students learn how to apply the concepts covered, this textbook is ideal for a one-semester or two-quarter course for undergraduate students.

Geology and Habitability of Terrestrial Planets

An integrated discussion of the similarities and differences between the atmospheres of various bodies of the solar system, including the Earth.

Alien Skies

The authors have put forth great efforts in gathering present day knowledge about different objects within our solar system and universe. This book features the most current information on the subject with

information acquired from noted scientists in this area. The main objective is to convey the importance of the subject and provide detailed information on the physical makeup of our planetary system and technologies used for research. Information on educational projects has also been included in the Radio Astronomy chapters.This information is a real plus for students and educators considering a career in Planetary Science or for increasing their knowledge about our planetary system.

Non-LTE Radiative Transfer in the Atmosphere

What is a planet? The answer may seem obvious; still, the definition of a planet has continuously evolved over the centuries, and their number has changed following successive discoveries. In 2006, the decision endorsed by the International Astronomical Union to remove Pluto from the list of planets has well illustrated the difficulty associated with their definition. The recent discovery of hundreds of exoplanets around nearby stars of our Galaxy opens a new and spectacular dimension to astrophysics. We presently know very little about the physical nature of exoplanets. In contrast, our knowledge on solar system planets has made huge progress over the past decades, thanks, especially, to space planetary exploration. The purpose of this book is first to characterize what planets are, in their global properties and in their diversity. Then, this knowledge is used to try to imagine the physical nature of exoplanets, starting from the few parameters we

know about them. Throughout, we keep in mind the ultimate question of the search for possible extraterrestrial life: Could life exist or have existed in the solar system and beyond? Thérèse Encrenaz is Emeritus Senior Scientist at the Centre National de la Recherche Scientifique. She works at the Observatoire de Paris, at the Laboratoire d'Etudes Spatiales et d'Instrumentation en Astrophysique (LESIA). She is a specialist of the study of planetary atmospheres, and has been involved in several space missions.

Theory of Planetary Atmospheres

Titan, the largest of Saturn's moons, shares remarkable similarities with Earth. Its thick atmosphere is composed primarily of nitrogen; it features the most complex organic chemistry known outside of Earth and, uniquely, hosts an analog to Earth's hydrological cycle, with methane forming clouds, rain, and seas. Using the latest data from the ongoing Cassini-Huygens missions, laboratory measurements, and numerical simulations, this comprehensive reference examines the physical processes that shape Titan's fascinating atmospheric structure and chemistry, weather, climate, circulation, and surface geology. The text also surveys leading theories about Titan's origin and evolution, and assesses their implications for understanding the formation of other complex planetary bodies. Written by an international team of specialists, chapters offer detailed, comparative treatments of Titan's known properties and discuss the latest frontiers in the Cassini-Huygens mission, offering students and

researchers of planetary science, geology, astronomy, and space physics an insightful reference and guide.

Planetary Atmospheres

Planets and Their Atmospheres: Origin and Evolution

Planetary Aeronomy

Given the universal interest in whether extraterrestrial life has developed or could eventually develop, it is vital that an examination of planetary habitability go beyond simple assumptions. This book has resulted from a workshop at the International Space Science Institute (ISSI) which brought together experts to discuss the multi-faceted problem of how the habitability of a planet co-evolves with the geology of the surface and interior, the atmosphere, and the magnetosphere.

Spectroscopy and Radiative Transfer of Planetary Atmospheres

This textbook details basic principles of planetary science that help to unify the study of the solar system. It is organized in a hierarchical manner so that every chapter builds upon preceding ones. Starting with historical perspectives on space exploration and the development of the scientific method, the book leads the reader through the solar system. Coverage explains that the origin and subsequent evolution of planets and their satellites can be explained by applications of certain basic

principles of physics, chemistry, and celestial mechanics and that surface features of the solid bodies can be interpreted by principles of geology.

Astrobiology

Planetary atmospheres are complex and evolving entities, as mankind is rapidly coming to realise whilst attempting to understand, forecast and mitigate human-induced climate change. In the Solar System, our neighbours Venus and Mars provide striking examples of two endpoints of planetary evolution, runaway greenhouse and loss of atmosphere to space. The variety of extra-solar planets brings a wider angle to the issue: from scorching "hot jupiters'' to ocean worlds, exo-atmospheres explore many configurations unknown in the Solar System, such as iron clouds, silicate rains, extreme plate tectonics, and steam volcanoes. Exoplanetary atmospheres have recently become accessible to observations. This book puts our own climate in the wider context of the trials and tribulations of planetary atmospheres. Based on cutting-edge research, it uses a grand tour of the atmospheres of other planets to shine a new light on our own atmosphere, and its relation with life.

Planetary Climates

This valuable reference presents detailed studies of eleven planetary atmospheres at the same time it offers an extensive survey of the principal chemical cycles that control the present composition and past history of these planetary atmospheres.

Planets: Ours and Others

For advanced undergraduate and beginning graduate students in atmospheric, oceanic, and climate science, Atmosphere, Ocean and Climate Dynamics is an introductory textbook on the circulations of the atmosphere and ocean and their interaction, with an emphasis on global scales. It will give students a good grasp of what the atmosphere and oceans look like on the large-scale and why they look that way. The role of the oceans in climate and paleoclimate is also discussed. The combination of observations, theory and accompanying illustrative laboratory experiments sets this text apart by making it accessible to students with no prior training in meteorology or oceanography.

Origin and Evolution of Planetary and Satellite Atmospheres

In this book, renowned scientists describe the complexity of exoplanetary atmospheres and all of the observational techniques that are employed to probe them. Readers will also find a panoramic description of the atmospheres of the planets within the Solar System, with explanation of considerations especially relevant to exoplanets. Over the past few years, thousands of exoplanets have been discovered orbiting around stars relatively close to the Solar System. Astronomers have revealed how varied these exoplanets are (rocky, icy, giant) and how diverse their architecture can be, confirming science fiction images in several cases and extending beyond the

human imagination in others. The natural next step is to study their atmospheres and to understand their chemical composition and the physical processes taking place in their interiors, with the aim of detecting biomarkers. This book will appeal to all who seek a comprehensive, state-of-the-art account of the latest knowledge in the rapidly developing and highly interdisciplinary field of exoplanet research.

Introduction to Circulating Atmospheres

In recent years, planetary science has seen a tremendous growth in new knowledge. Deposits of water ice exist at the Moon's poles. Discoveries on the surface of Mars point to an early warm wet climate, and perhaps conditions under which life could have emerged. Liquid methane rain falls on Saturn's moon Titan, creating rivers, lakes, and geologic landscapes with uncanny resemblances to Earth's. Vision and Voyages for Planetary Science in the Decade 2013-2022 surveys the current state of knowledge of the solar system and recommends a suite of planetary science flagship missions for the decade 2013-2022 that could provide a steady stream of important new discoveries about the solar system. Research priorities defined in the report were selected through a rigorous review that included input from five expert panels. NASA's highest priority large mission should be the Mars Astrobiology Explorer Cacher (MAX-C), a mission to Mars that could help determine whether the planet ever supported life and could also help answer questions about its geologic and climatic history. Other projects should include a

mission to Jupiter's icy moon Europa and its subsurface ocean, and the Uranus Orbiter and Probe mission to investigate that planet's interior structure, atmosphere, and composition. For medium-size missions, Vision and Voyages for Planetary Science in the Decade 2013-2022 recommends that NASA select two new missions to be included in its New Frontiers program, which explores the solar system with frequent, mid-size spacecraft missions. If NASA cannot stay within budget for any of these proposed flagship projects, it should focus on smaller, less expensive missions first. Vision and Voyages for Planetary Science in the Decade 2013-2022 suggests that the National Science Foundation expand its funding for existing laboratories and establish new facilities as needed. It also recommends that the program enlist the participation of international partners. This report is a vital resource for government agencies supporting space science, the planetary science community, and the public.

Theory of Planetary Atmospheres

The principal elements of the theory of polarized light transfer in planetary atmospheres are expounded in a systematic but concise way. Basic concepts and practical methods are emphasized, both for single and multiple scattering of electromagnetic radiation by molecules and particles in the atmospheres of planets in the Solar System, including the Earth, and beyond. A large part of the book is also useful for studies of light scattering by particles in comets, the interplanetary and interstellar medium, circumstellar

disks, reflection nebulae, water bodies like oceans and suspensions of particles in a gas or liquid in the laboratory. Throughout the book symmetry principles, such as the reciprocity principle and the mirror symmetry principle, are employed. In this way the theory is made more transparent and easier to understand than in most papers on the subject. In addition, significant computational reductions, resulting from symmetry principles, are presented. Hundreds of references to relevant literature are given at the end of the book. Appendices contain supplementary information such as a general exposition on properties of matrices transforming Stokes parameters of light beams. Each chapter concludes with a number of problems with answers or hints for solution. The readers should have some basic knowledge of physics and mathematics. The book is suitable as a textbook for advanced undergraduates and graduate students. It will also be of interest to science professionals in one of the many disciplines in which electromagnetic scattering plays an important role, like astrophysics, atmospheric optics, remote sensing, marine optics, biophysics and biomedicine.

Exoplanetary Atmospheres

Humanity has long been fascinated by the planet Mars. Was its climate ever conducive to life? What is the atmosphere like today and why did it change so dramatically over time? Eleven spacecraft have successfully flown to Mars since the Viking mission of the 1970s and early 1980s. These orbiters, landers

and rovers have generated vast amounts of data that now span a Martian decade (roughly eighteen years). This new volume brings together the many new ideas about the atmosphere and climate system that have emerged, including the complex interplay of the volatile and dust cycles, the atmosphere-surface interactions that connect them over time, and the diversity of the planet's environment and its complex history. Including tutorials and explanations of complicated ideas, students, researchers and non-specialists alike are able to use this resource to gain a thorough and up-to-date understanding of this most Earth-like of planetary neighbours.

An Introduction to Planetary Atmospheres

Earth as an Evolving Planetary System, Second Edition, examines the various subsystems that play a role in the evolution of the Earth. These subsystems include such components as the crust, mantle, core, atmosphere, oceans, and life. The book contains 10 chapters that discuss the structure of the Earth and plate tectonics; the origin and evolution of the crust; the processes that leave tectonic imprints in rocks and modern processes responsible for these imprints; and the structure of the mantle and the core. The book also covers the Earth’s atmosphere, hydrosphere, and biosphere; crustal and mantle evolution; the supercontinent cycle; great events in Earth history; and the Earth in comparison to other planets. This book is meant for advanced undergraduate and graduate students in Earth

Sciences, with a basic knowledge of geology, biology, chemistry, and physics. It also may serve as a reference tool for specialists in the geologic sciences who want to keep abreast of scientific advances in this field. Kent Condie's corresponding interactive CD, Plate Tectonics and How the Earth Works, can be purchased from Tasa Graphic Arts here: http://www.tasagraphicarts.com/progptearth.html Two new chapters on the Supercontinent Cycle and on Great Events in Earth history New and updated sections on Earth's thermal history, planetary volcanism, planetary crusts, the onset of plate tectonics, changing composition of the oceans and atmosphere, and paleoclimatic regimes Also new in this Second Edition: the lower mantle and the role of the post-perovskite transition, the role of water in the mantle, new tomographic data tracking plume tails into the deep mantle, Euxinia in Proterozoic oceans, The Hadean, A crustal age gap at 2.4-2.2 Ga, and continental growth

Giant Planets of Our Solar System

For advanced undergraduate and beginning graduate students in atmospheric, oceanic, and climate science, Atmosphere, Ocean and Climate Dynamics is an introductory textbook on the circulations of the atmosphere and ocean and their interaction, with an emphasis on global scales. It will give students a good grasp of what the atmosphere and oceans look like on the large-scale and why they look that way. The role of the oceans in climate and paleoclimate is also discussed. The combination of observations, theory

and accompanying illustrative laboratory experiments sets this text apart by making it accessible to students with no prior training in meteorology or oceanography. * Written at a mathematical level that is appealing for undergraduates and beginning graduate students * Provides a useful educational tool through a combination of observations and laboratory demonstrations which can be viewed over the web * Contains instructions on how to reproduce the simple but informative laboratory experiments * Includes copious problems (with sample answers) to help students learn the material.

Astrophysics of Exoplanetary Atmospheres

Planetary Science is an exciting, fast–moving, interdisciplinary field with courses taught in a wide range of departments, including astronomy, physics, chemistry, earth sciences and biology. Planets and Planetary Systems is a well–written, concise introductory textbook on the science of planets within our own and other solar systems. Keeping mathematics to a minimum, assuming only a rudimentary knowledge of calculus, the book begins with a description of the basic properties of the planets in our solar systems, and then moves on to compare them with what is known about planets in other solar systems. It continues by looking at the surfaces, interiors and atmospheres of the planets and then covers the dynamics and origin of planetary systems. The book closes with a look at the role of life in planetary systems. · An accessible, concise

introduction to planets and planetary systems · Uses insights from all the disciplines underlying planetary science · Incorporates results from recent planetary space missions, such as Cassini to Saturn and a number of missions to Mars · Well illustrated throughout, including a colour plate section Planets and Planetary Systems is invaluable to students taking courses in planetary science across a wide range of disciplines and of interest to researchers and many keen amateur astronomers, needing an up–to–date introduction to this exciting subject.

The Atmosphere and Climate of Mars

Ch. 1. Introduction and overview. 1.1. General introduction. 1.2. Basic properties of the Earth's atmosphere. 1.3. What is LTE? 1.4. Non-LTE situations. 1.5. The importance of non-LTE. 1.6. Some historical background. 1.7. Non-LTE models. 1.8. Experimental studies of non-LTE. 1.9. Non-LTE in planetary atmospheres. 1.10. References and further reading -- ch. 2. Molecular spectra. 2.1. Introduction. 2.2. Energy levels in diatomic molecules. 2.3. Energy levels in polyatomic molecules. 2.4. Transitions and spectral bands. 2.5. Properties of individual vibration-rotation lines. 2.6. Interactions between energy levels. 2.7. References and further reading -- ch. 3. Basic atmospheric radiative transfer. 3.1. Introduction. 3.2. Properties of radiation. 3.3. The radiative transfer equation. 3.4. The formal solution of the radiative transfer equation. 3.5. Thermodynamic equilibrium and local thermodynamic equilibrium. 3.6. The source function in non-LTE. 3.7. Non-LTE situations. 3.8.

References and further reading -- ch. 4. Solutions to the radiative transfer equation in LTE. 4.1. Introduction. 4.2. Integration of the radiative transfer equation over height. 4.3. Integration of the radiative transfer equation over frequency. 4.4. Integration of the radiative transfer equation over solid angle. 4.5. References and further reading -- ch. 5. Solutions to the radiative transfer equation in non-LTE. 5.1. Introduction. 5.2. Simple solutions for radiative transfer under non-LTE. 5.3. The full solution of the radiative transfer equation in non-LTE. 5.4. Integration of the RTE in non-LTE. 5.5. Intercomparison of non-LTE codes. 5.6. Parameterizations of the non-LTE cooling rate. 5.7. The Curtis matrix method. 5.8. References and further reading -- ch. 6. Non-LTE modelling of the Earth's atmosphere I: CO2. 6.1. Introduction. 6.2. Useful approximations. 6.3. Carbon dioxide, CO2. 6.4. References and further reading -- ch. 7. Non-LTE modelling of the Earth's atmosphere II: Other infrared emitters. 7.1. Introduction. 7.2. Carbon monoxide, CO. 7.3. Ozone, O3. 7.4. Water vapour, H2O. 7.5. Methane, CH4. 7.6. Nitric oxide, NO. 7.7. Nitrogen dioxide, NO2. 7.8. Nitrous oxide, N2O. 7.9. Nitric acid, HNO3. 7.10. Hydroxyl radical, OH. 7.11. Molecular oxygen atmospheric infrared bands. 7.12. Hydrogen chloride, HC1, and hydrogen fluoride, HF. 7.13. NO+. 7.14. Atomic Oxygen, O (3P), at 63[symbol]m. 7.15. References and further reading -- ch. 8. Remote sensing of the non-LTE atmosphere. 8.1. Introduction. 8.2. The analysis of emission measurements. 8.3. Observations of carbon dioxide in emission. 8.4. Observations of ozone in emission. 8.5. Observations of water vapour in emission. 8.6. Observations of carbon monoxide in emission. 8.7.

Observations of nitric oxide in emission. 8.8. Observations of other infrared emissions. 8.9. Rotational non-LTE. 8.10. Absorption measurements. 8.11. Simulated limb emission spectra at high resolution. 8.12. Simulated Nadir emission spectra at high resolution. 8.13. Non-LTE retrieval schemes. 8.14. References and further reading -- ch. 9. Cooling and heating rates. 9.1. Introduction. 9.2. CO2 15 f[symbol]m cooling. 9.3. O3 9.6[symbol]xm cooling. 9.4. H2O 6.3[symbol]m cooling. 9.5. NO 5.3[symbol]m cooling. 9.6. O(3Pi) 63[symbol]m cooling. 9.7. Summary of cooling rates. 9.8. CO2 solar heating. 9.9. References and further reading -- ch. 10. Non-LTE in planetary atmospheres. 10.1. Introduction. 10.2. The terrestrial planets: Mars and Venus. 10.3. A non-LTE model for the Martian and Venusian atmospheres. 10.4. Mars. 10.5. Venus. 10.6. Outer planets. 10.7. Titan. 10.8. Comets. 10.9. References and further reading.

Fundamental Planetary Science

Ongoing advances in Solar System exploration continue to reveal its splendour and diversity in remarkable detail. This undergraduate-level textbook presents fascinating descriptions and colour images of the bodies in the Solar System, the processes that occur upon and within them, and their origins and evolution. It highlights important concepts and techniques in boxed summaries, while questions and exercises are embedded at appropriate points throughout the text, with full solutions provided. Written and edited by a team of practising planetary

scientists, this third edition has been updated to reflect our current knowledge. It is ideal for introductory courses on the subject, and is suitable for self-study. The text is supported by online resources, hosted at www.cambridge.org/solarsystem3, which include selected figures from the book, self-assessment questions and sample tutor assignments, with outlines of suggested answers.

Exoplanet Atmospheres

This Second Edition of An Introduction to Atmospheric Radiation has been extensively revised to address the fundamental study and quantitative measurement of the interactions of solar and terrestrial radiation with molecules, aerosols, and cloud particles in planetary atmospheres. It contains 70% new material, much of it stemming from the investigation of the atmospheric greenhouse effects of external radiative perturbations in climate systems, and the development of methodologies for inferring atmospheric and surface parameters by means of remote sensing. Liou's comprehensive treatment of the fundamentals of atmospheric radiation was developed for students, academics, and researchers in atmospheric sciences, remote sensing, and climate modeling. Features Balanced treatment of fundamentals and applications Includes over 170 illustrations to complement the concise description of each subject Numerous examples and hands-on exercises at the end of each chapter About the Author Dr. K. N. Liou is Professor of Atmospheric Sciences at the University of California,

Los Angeles. He is a member of the National Academy of Engineering and Fellow of AAAS, AGU, AMS, and the Optical Society of America. Professor Liou received the Jule G. Charney Award from AMS in 1998 "for his pioneering work in the theory and application of radiative transfer and its interaction with clouds."

An Introduction to Atmospheric Radiation

An authoritative introduction for graduate students in astronomy, planetary science and earth science.

Planets and Planetary Systems

This book is a comprehensive discussion of all issues related to atmospheric electricity in our solar system. It details atmospheric electricity on Earth and other planets and discusses the development of instruments used for observation.

Introduction to Planetary Science

This book reviews the current state of knowledge of the atmospheres of the four giant gaseous planets. It is the first book to contain all the latest data and background information on these planets in one handy volume. Current theories of their formation are reviewed. The book clearly explains all specialist terms, and it discusses the pros and cons of ground versus space-based observations of giant planets.

Titan

Planetary Aeronomy is a modern and concise introduction to the underlying physical and chemical processes that govern the formation and evolution of the upper atmospheres of planets. The general approach employed permits consideration of the growing number of extrasolar planets, the detailed observation of which will become possible over the next decades. The book explains the physics behind many atmospheric processes, which are relevant for the evolution of planetary atmospheres and their water inventories, and also contains useful scaling laws and analytical expressions that can be applied to any planet. Readers thus gain insight into the evolution of terrestrial planets and their long-time habitability, atmospheric stability, etc. This volume can be used both as graduate textbook for students wishing to specialize in the field as well as succinct compendium for researchers in the field.

Earth as an Evolving Planetary System

This concise, sophisticated introduction to planetary climates explains the global physical and chemical processes that determine climate on any planet or major planetary satellite--from Mercury to Neptune and even large moons such as Saturn's Titan. Although the climates of other worlds are extremely diverse, the chemical and physical processes that shape their dynamics are the same. As this book makes clear, the better we can understand how various planetary climates formed and evolved, the better we can understand Earth's climate history and future.